

Modelling and Eliciting Organisational and Information System Requirements for Medical Information Systems

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Abstract

In this paper an outline of a modelling technique will be presented that allows for the encapsulation and analysis of the social and technical aspects of an organisational information system. This notation is used to construct and analyse both the static and dynamic models of organisations and organisational behaviour. The construction and analysis is achieved through the use of concepts such as role and responsibility. The conceptual modelling framework is then applied to a case study. This case study is based upon an accident and emergency department of an inner city hospital situated within the centre of Dublin, Ireland.

INTRODUCTION

In [3] the assertion is made that computers are not just instrumental means of production, they also condition and mediate social relationships. This mediation can take the form of decisions being made by the computer that have a direct impact on a person's life. For example, a medical information system is just a pure information system but also a safety critical system and an agent of change. The issues associated with the adoption and application of a medical information system are not just availability of service and integrity of information, but also how the information system will change the work patterns of the organisation. Conventional systems analysis has largely concentrated on information processing rather than taking a wider view of the problem which would consider the The framework presented within this paper views an information system as a socio-technical system. That is to say that it attempts to model the wider issues that surround and information system both at the social, behavioural, technical and moral level. This is achieved through the merger of the concepts of role and responsibility, and a linguistical model of interactions, within a modelling framework.

One of functions of this modelling framework is for it to act as a medium of communication. This is so

that both the problem owners and problem solvers can build up a consensus that they are specifying and reasoning about the same problem. Another purpose of the modelling framework is to facilitate in the representation and validation of the problem.

By modelling an organisation and how it manipulates its resources and value system we are empowering it with the ability to model itself and its role within a society. This ability provides an organisation with the capability to embrace change and view it in a positive manner [5]. As a result organisations can at last begin to explore the consequences of adopting an information system and plan for the future.

THE BASIC CONCEPTS

The modelling concepts are perhaps the key aspect that makes this framework different from more conventional approaches to design. Enterprise modelling [1] provides a framework for representing and reasoning about the IT system as a component of a wider environment that is the organisation whose needs it is designed to serve. We have found that this form of modelling ensures an adequate representation of the structural and organisational aspects of the problem. It makes explicit policy issues and assumptions that cannot easily be stated. A major characteristic of the modelling framework presented in this paper is that responsibilities and relationships are modelled rather than activities. This enables us to elicit, capture, and represent information in the context of those who use it.

The enterprise modelling language has been designed to represent the structure of organisations. It has two related but distinct purposes: 1) to identify the requirements owners and their positions and roles within the organisation in order to demonstrate completeness of the requirements elicitation process, and 2) to identify the user community (and others affected by the proposed IT system) and their roles and responsibilities within the organisation in order to demonstrate completeness of the requirements modelling process.

The Concept of Role

The our concept of role [1] allows us to distinguish: a) agents, and the relationships between them; and b) the network of activities that interact through information flows and are structured into tasks and operations. Our modelling framework enables us to represent and analyse the relations between these ('a' and 'b') and to represent the way in which they operate in real organisations.

The Concept of Agency

Our aim is to describe and reason about organisations that embody both a social and a technical system. These however comprise one single system, a socio-technical system, and as such cannot be described or modelled only in terms of state and behaviour as a purely technical system might be, since there is a fundamental difference between social and technical systems. It is to be able to differentiate between social and technical objects (i.e. between people and computers) that we introduce the idea of agency [1]. A machine may perform the same tasks as a person, but the person will hold responsibilities for those tasks in contrast to the machine which cannot hold responsibility. The person is said to be an agent and hold the agency.

Responsibility Modelling

We will define responsibility as a relationship between two agents regarding a specific state of affairs [4], such that the holder of the responsibility is responsible to the giver of the responsibility, the responsibility principal. We will define responsibility consists of: a) who is responsible to whom; b) the state of affairs for which the responsibility is held; c) the nature of relationship (these include peer, power and service) d) the type of responsibility (these include accountability, blameworthiness, legal liability). A computer can not be held responsible for any things as responsibility implies issues such as culpability and restitution. Clearly a computer can not be punished for its actions, so we need to examine where that responsibility might lie. Thus if an information system is making a decision, or even helping in the making of a decision, then it needs to be clear when, where and to whom the responsibilities lie.

Service Modelling

The life cycle that we go through for a service from negotiation, delivery to restitution are depicted in Figure 1. This diagram forms a framework from

within which the problem solver can begin to examine how the current system functions and how an information system may assist the organisation in the meeting of its objectives.

Each stage defines its own set of issues and concerns. For example, in the stage restitution we can examine the nature of that restitution by answer questions such as, to whom do we make restitution and who makes its, as well as does this restitution involve any litigation. For each stage we can examine the conditions under which we can engage in this stage and the conditions under which we exit this stage, as well as the organisational objects manipulated in that stage.

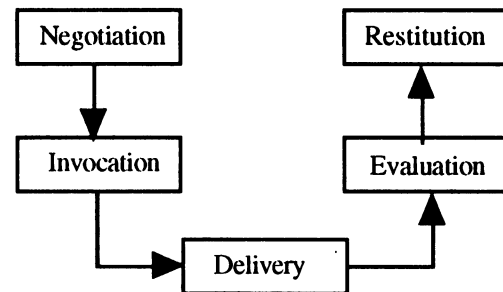


Figure 1 The Service Life Cycle Model

Within the negotiation stage we would want to examine the conversation which leads to the definition of a service, the agents and the relationships associated with its invocation, delivery, evaluation. For example, within this section we could want to specify how and by whom a service will be evaluated. Issues such as when can some one engage in this conversation, with whom should the conversation be engaged and under what conditions can the conversation be engaged are just a few of the questions that we would seek to answer in this section. In addition, within this stages we would also want to examine what responsibilities and resources where created and manipulated as signs of the services invocation and evaluation.

For the invocation phase of the service life cycle we would want to examine issues such as under what conditions can the service be invoked. We would also want to examine the conversation concerned the services invocation and look at things such as what happens in the invocation fails, and what access rights on resources and responsibilities are required. Within the delivery phase of the service life cycle we can examine how a service is delivered, what organisational objects are manipulated by that delivery and whom is to delivery the service and to whom is the service to be delivered. Again we can

examine the roles that these agents or agencies play within the whole of the life cycle.

For the evaluation phase we would want to examine issues associated with how the service was to be evaluated and by whom. In addition, we would want to make clear by examination the conditions under which the evaluation phase of the service life cycle model is started and terminated. Questions such as what metrics will be used, are there any legal methods to evaluate this service and how is this service to be paid for, all fall within the scope of this phase of the service life cycle model. For example we could now examine the question, is the evaluation of the service the same agent or agency who delivers it?

The restitution phase of the service life cycle model is concerned with issues such as how is payment to be made for this service, or how does the consumer of the service get legal compensation for anything that has gone wrong.

THE CASE STUDY - THE CITY HOSPITAL

Introduction

This case study is taken from an accident and emergency (A&E) department located in an inner city hospital of Dublin. Various social, economic and political factors conspire to make this case study interesting. For the purposes of this paper however, a condensed problem domain will be presented without generalisation and analysed from only one perspective. It should be remembered though that this problem forms part of a bigger problem, which in turn fits into the social, economic, and political environment of the country.

Characterisation of an A&E Dept

The primary function performed by the A&E department is to provide accident and emergency services to the public. This has evolved into a second function, which constitutes provision of low-grade medical services to the local populace, where patients use the A&E department as an alternative to general practice.

The A&E department is functionally related to a number of other departments within the hospital upon which it relies for services, e.g., pathology, radiology, pharmacy, and central administration. The A&E department internally consists of a small set of separate and distinct entities, e.g., senior nurse, consultant, junior doctors, junior nurses, and receptionists.

For the purposes of this case study we will concentrate on one aspect of the nurse's role within the A&E department. By modelling this role we will attempt to derive requirements. The role of the junior nurse upon which we will focus is that of administering drugs to the patient.

The Role of the Junior Nurse

Under Irish law, the person who administers a drug is responsible for the effect that the drug has on the patient. Thus, if the wrong drug is prescribed and administered, the person is held responsible under the law. This gives rise to the nurses having to perform, and being taught to perform, some of the functions normally associated with a doctor. When administering drugs to a patient, one nurse administers the drug while another nurse observes to make sure that the correct procedures are followed and that the recommended dosage of a particular drug is administered. Both nurses then sign for the drugs in the patient's records. Drug usage is monitored by the chief nurse as the unit contains little stocks of drugs, particularly controlled drugs such as morphine. The junior nurse is responsible for ensuring that the use of such drugs is recorded.

If the nurse is unhappy with the diagnosis, she can refuse to administer the drug. Within the health service it is impossible for anyone to be forced to administer a drug. Should the nurse decide upon this course of action, she is required to report it to the chief nurse. The resolution of this conflict then becomes the responsibility of the chief nurse. Should the chief nurse be unable to resolve this situation, she may also invoke a higher authority (the hospital's central administration) to deal with the situation. It then becomes their responsibility. Within the A&E department, there are therefore two management structures: one for the doctors with the consultant at their head; and one for the nurses with the chief nurse at their head. These two management structures only come together in the central administration of the hospital.

Modelling the System

The purpose in modelling the organisational system from the perspective of the junior nurse is to elicit, represent, and validate requirements that have either a direct, or an indirect, impact on the Organisational Information Technology system. In Figure 2, the rectangles represent the agencies or agents that contain the structural and functional roles. The structural roles are connected together with lines of double thickness, while the functional relationships

are connected together with lines of a single thickness. The functional roles (*problem owner*, *problem repairer*) are shorthand for the kind of behaviours (conversations) that the various agencies or agents may engage in (e.g., the problem owner can report the existence of a problem, and the problem repairer can mend it). The structural roles (*consumer*, *supplier*) are shorthand for the framework of responsibilities that permit and give meaning to these behaviours i.e. it describes the nature of the 'social' relationship between the two agents.

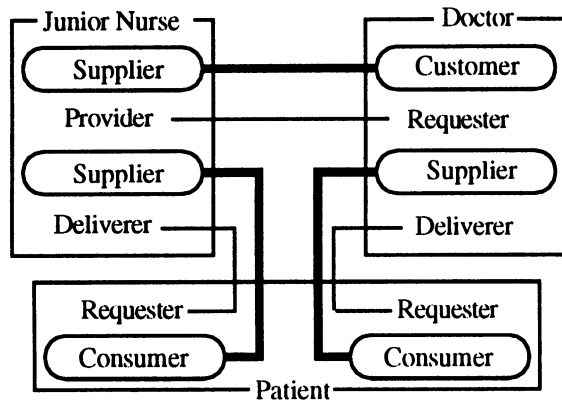


Figure 2 An Overview of the Structural System

The lines that join the functional and the structural roles represent the fact that a relation between two agents may be one of interaction or one of responsibility. Responsibility and interactions are related to each other through activities such that responsibilities only arise and are fulfilled through interactions. In short, the links between them are functional and structural relationships. In the role relation diagram depicted in Figure 5, the doctor and nurse have to negotiate for the delivery of a specified service to the patient. Due to the nature of the relationship, the structural relationship that exists between them is that of supplier - customer. The requester - provider functional relationship that is associated with the doctor - nurse structural relationship denotes the negotiation process by which the doctor attempts to persuade the nurse to perform a service. The service that the nurse performs is the delivery of health care to a third agent, i.e., the patient. As a result of the delivery of this service, both the doctor and the nurse fulfill their responsibilities. The structural relationship between the nurse and the doctor is one of customer - supplier. The nature of the conversation between them is one of negotiation, as the doctor is attempting to convince the nurse to treat the patient in a prescribed manner. As the nurse is legally responsible for any treatment he/she administers, he/she has to decide if she believes that the prescribed treatment for the patient

by the doctor is appropriate and adequate. In order for her to make a decision she has to perform a brief diagnosis based on the information that she has access to.

The conversations that a nurse would engage in to administer some drugs to a patient at the request of a doctor will now be modelled. In the following diagrams, a rectangle is used to denote a speech act, and a triangle is used to signify those points in a conversation where different courses of action may arise (mental acts). In addition an oval is used to denote an instrumental act, and a rounded rectangle is used to express the starting or terminating points of the functional unit. The notation is described and explained in detail in [2].

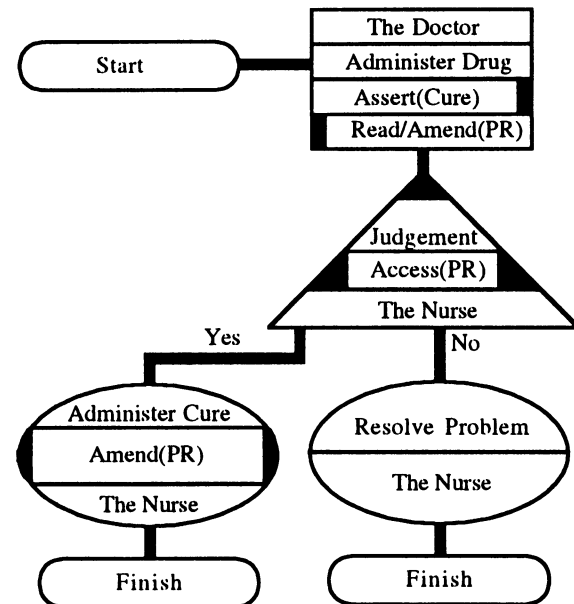


Figure 3 A Conversation Diagram of the Nurse's Decision

In Figure 3, the conversation begins with the doctor requesting the nurse to administer a drug to the patient. In so doing he/she needs to have read and write (read/amend) access to all the patient's records (PR) so that they can be augmented by adding what drug he/she thinks is required. In requesting the nurse to administer a drug to the patient, the doctor is asserting an informational attribute and mirroring this assertion in the patient's records by recording it there. This informational attribute is the proposition that a particular drug is what the patient requires as part of their cure at this point in time.

The nurse now has to make a decision as to whether he/she is going to administer the drug. The law consequently generates several direct and indirect

requirements on the organisational information technology system. From the nurse's perspective, if the correct decision is to be made, then access to all the informational objects and attributes related to the patient is required. The nurse must be able to review them and form an opinion of what ails the patient so that a cure may be formulated and administered. In the above diagram, the term *Access(PR)* is used to express the accessing of all the informational objects and informational attributes related to the patient. Having identified that accessing of records is required, the nature of the accessing itself can be explored. We find that the nurse may only read and that under these conditions is not allowed write access. Thus a nurse may read the result of a test that has been performed on the patient, but may not request that a particular test be performed. We may also look at the mental act and ask the question, "what type of decision is it?" For example, is it a decision for which a set of rules governing the outcome may be given? Or is it a decision that calls upon the individual to make some kind of value judgement? The latter kind is a mental act that one may want a computer to assist in the making of, but not one that one would want the computer to make. The decision that the nurse is required to make is a value judgement due to legal aspects of the resulting action. For this reason, the nurses have special educational needs. Consequently, they are not just to be taught to apply a dressing or administer a drug; they are required to make informal diagnoses upon which they act. Thus they need to be taught how to make them and what information they need to make them.

The decision has two possible outcomes: either the nurse can choose to administer the drug, or he/she can refuse. Because of the legal aspects of the system, under no conditions can the nurse be forced to administer the drug. Thus, should he/she decide to refuse the doctor's request then he/she must invoke steps to resolve the conflict. We may point to the oval which represents the conversation that the nurse would engage in to resolve the conflict and ask "what informational objects and attributes are required by this conversation?" From the perspective of the hospital, these steps are formally defined and clearly stated for all to see. Assume, however, that the nurse decides to comply with the doctors request.

SUMMARY

The most common problem of requirements engineering in the design and implementation of complex IT systems is combining differing representations of the system and its environments. The operational, organisational, and social environments of a system all possess different

characteristics. Hence the core of this approaches philosophy is its advocacy of involving policy makers/problem owners throughout the design of the system. It is a process of shifting the balance of responsibility between system owner and system designer away from the 'owner states, designer solves' model towards a relationship in which the problem solver helps the problem owner understand the problem and the problem owner helps the problem solver understand the implications of possible solutions.

Furthermore, used in the context of enterprise modelling, interaction analysis and role relations diagramming have shown, through the use of various case studies, their usefulness in dealing with an organisation's requirements and policies. A major advantage is the degree of flexibility it places within the analyst's control.

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